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Epistemic Motivation and Conceptual Change

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ABSTRACT

While the conceptual change model of learning has contributed much to our understanding of how children learn science, recent criticisms of the model point out its lack of attention to motivational issues. This paper examines one such motivational construct of importance to the model: epistemic motivation. After a description of the construct, we describe our work on developing an instrument to measure epistemic motivation, and we discuss interview data that also helps explicate how this construct operates in children. We also discuss links to other areas of the educational literature.

The conceptual change model of learning (Posner, Strike, Hewson, & Gertzog, 1982) has been the focus of much attention and research in the science education community, and this research has contributed greatly to our understanding of how children learn science. All the same, there have been a number of criticisms directed at the model. Recent work by Pintrich and his colleagues (Pintrich, Marx, & Boyle, in press a, in press b) focuses on one specific criticism — the model's lack of attention to motivational constructs. Indeed, Strike and Posner (1992), in a recent revision of their own model, suggest this as one important area that needs to be addressed in improving the model. In this paper, we will describe one particular motivational construct that appears to have important implications for conceptual change: epistemic motivation, or one's beliefs towards knowledge and the process of building knowledge. We will describe our work, still in progress, to design an instrument to measure this construct, and to determine the relevance of this construct for the development of knowledge by children. Finally, we will discuss links to other areas of educational research which may relate to epistemic motivation and help provide a more systemic view of how children learn.

Motivation and Conceptual Change

While we would refer those interested in a more detailed motivational critique of conceptual change to the work of Pintrich et al. cited above, we feel it important to discuss a few basic issues here. Conceptual change, being founded upon models of scientific theory change, is essentially a "cold" cognitive model (Brown, Bransford, Ferrara, & Campione, 1983); a highly rational view of learning with little or no reference to motivational constructs such as goals, value beliefs, or self-efficacy beliefs. In fact, given the model's reliance on Piagetian mechanisms for learning, i.e., accommodation and assimilation, one might argue that there is one single de facto motivational construct in the model: disequilibration. Kitchener (1992, p.131) describes the situation in the following manner:

> Simply put, the reason individuals make such conceptual change, and hence the underlying motive operating in such cases, is epistemic in nature: the earlier cognitive structure was disequilibrated, inadequate as a problem-solving device, cognitively inconsistent, and so forth. Because such epistemic structures are inadequate, this is a sufficient condition for rational change; hence it is sufficient as a motivating condition for making the change in question. The only motive needed to explain conceptual transitions, therefore, is a logical and rational one.

However, the educational literature on motivation contradicts the notion that, in typical learning situations such as classrooms, inadequacy of cognitive structures is sufficient reason for change. Strike and Posner state part of the problem (1992, p.161):

> Clearly, for learners, what we assume about classroom events is not all that is going on. For some learners, it may not be what is going on at all. The problem to be solved in the classroom for some learners is that of discovering how to get a good grade. For others, the problem may be discovering how to maintain a sense of self-worth in the face of a subject matter that is unintelligible. Or students may conceptualize the task as a piece of academic work (Doyle, 1983) instead of scientific inquiry. There are many possibilities.

These comments focus primarily on students being motivated by completing the academic tasks that they face. There are other motivational issues that need to be addressed as well, such as getting the student to engage in the academic tasks in the first place, in the face of competition for the student's attention with social goals unrelated to schooling.

That is not to say the conceptual change model is incompatible with motivational issues. There are several openings or "hooks" to integrate motivational constructs. For example, accepting the fruitfulness of a new conception, one of the conditions for conceptual change, implies a role for a student's value judgments about the conception as well as his or her goals, such as how this new information might help in attaining a desired end. In addition, the metaphor of a conceptual ecology warrants motivational considerations. Whereas a critical aspect of a conceptual ecology is the learner's epistemological beliefs, based in part upon epistemologies of science, a recent work in social psychology suggests an alternative based upon motivation: Lay Epistemic Theory.

Epistemic Motivation

Lay Epistemic Theory or LET (Kruglanski, 1990a, b), developed from social cognitive theory, attempts to explain the views of "just plain folk" on the nature of knowledge and knowledge construction. It posits that people actively try to make sense of the world – that they

are theory-builders – and that they continually go through a process of hypothesis generation and testing in response to their interactions with the real world, in a manner similar to that used by scientists. In this, LET is similar to constructivist theories of learning. Kruglanski adds, however, that this process involves both motivation and cognition, and that people tend not to test their theories rigorously, if at all.

LET proposes two parts to the process of knowledge building. The first involves an individual's cognitive competence. This competence consists of the long term *availability* of constructs in one's memory as well as the short term *accessibility* of those constructs from memory. Cognitive competence, in and of itself, is similar to many other cold cognitive views of learning. The second aspect of knowledge building is a person's epistemic motivation, or one's beliefs about the knowledge building process or, as Kruglanski puts it, knowledge as an object.

These beliefs help define what Kruglanski calls an individual's epistemic state, which guides that person in her search for knowledge and in the nature of her cognitive activity. This epistemic state can be describe in terms of two dimensions — disposition towards cognitive closure and specificity of closure. In terms of the former dimension, one may either be seeking cognitive closure, desiring to settle on an answer as soon as possible, or avoiding closure, trying to keep the knowledge building process going. As for the latter dimension, one may decide that any answer is suitable (non-specific closure) or that there is one correct answer that needs to be determined (specific closure). Given these two dimensions, four basic epistemic states are possible (Figure 1).

In the language of LET, cognitive activity can be either frozen or unfrozen. When cognition is frozen, some form of closure has been attained and cognitive activity has been, for the most part, halted on that particular concept. Unfreezing cognition involves reversing or delaying closure, and reexamining conceptual understanding. Whether cognition is frozen or unfrozen depends on whether there are discrepancies in a person's *epistemic state*, rather than in his cognitive structures. In other words, inadequate conceptual structures may not be sufficient reason for a person to re-engage in the knowledge building process. What does matter is how that

person's perceptions of the world compare with his epistemic state. This comparison influences cognitive activity by initiating cognition, directing or redirecting thinking, or by leading to cognitive closure. For example, a student, believing she has completed an non-graded homework assignment, may hear from a classmate that the teacher is going to collect it for a grade. This discrepancy may lead to a change in her epistemic state; she may get out her assignment and check to see if it really is complete, she may also check her answers to see if they are correct. The former suggests a unfreezing cognition then seeking non-specific closure, while the latter suggests specific closure instead. Finally, once she has judged that her goals are met and has attained closure, cognition on the task will be frozen once again.

A number of factors related to a person's epistemic state guide this process of freezing or unfreezing cognition. Primary in LET is the notion of a cost/benefit analysis of the cognitive activity. What might be gained or lost by changing the status quo? Are there time constraints which would bring some sort of penalty if an answer is not decided upon quickly? What are the costs of seeking premature closure, if a better answer can be found? These are the sorts of questions that may alter a person's epistemic state and, therefore, influence the nature of her cognition. Such considerations (time constraints, costs of incorrect information) are examples of situational cues resulting from tasks demands or contexts. It may also be the case that stable individual differences exist in the need for cognitive closure, and that this need may influence the cost/benefit analysis (Webster & Kruglanski, under review). An individual's prior knowledge (also an important construct for conceptual change) may also influence this analysis. For example, someone with little prior knowledge and seeking non-specific closure (i.e., any answer is suitable) may engage in an intense search for knowledge (unfreezing) to obtain an answer as quickly as possible. On the other hand, if she has a great deal of prior knowledge on a topic, her cognition may stay frozen as she may believe she already has a suitable answer to a problem.

In the context of classroom instruction, one aspect that we feel is important is the culture of schooling itself; specifically, the nature of academic work (Doyle, 1983). This lends a common perception to the expectations of students and teachers in doing learning tasks that may

promote certain epistemic states, and varying from these expectations may be done in conflict with these states. To further illustrate, consider the implications of developing a "community of learners" similar to that of a scientific discourse community; an increasingly popular notion in recent research on learning (cf. Cohen & Lotan, 1990; Marshall, 1990; Schwab, 1976, 1975). The idea of public construction, sharing, and critical discussion of knowledge stands very much in contrast to the workplace metaphor predominant in schools; it seems apparent that these metaphors would also support disparate views towards knowledge and epistemic states.

Researching Epistemic Motivation in Children

A major concern in examining how epistemic motivation might inform conceptual change models of learning is that LET was developed through studies on adult knowledge construction and decision making — the theory does not speak to whether epistemic motivation functions in the same manner in children, what differences may exist, and to what extent developmental differences occur in children's beliefs towards knowledge. Research on children's naive theories of mind (Wellman, 1990) and of biology (Carey, 1985) suggest that these issues require serious study before trying to integrate LET into a model of motivated conceptual change.

The focus of our current research, presented here, is to examine how epistemic motivation exists and functions for children of elementary school age (grades three through five). Because of the caveats mentioned above, we do not seek to confirm that the adult structures of LET exist in children; rather, we are proceeding in a manner which we believe will allow us to discern the nature of epistemic motivation in children as it pertains to school learning. We are conducting our investigation primarily through a grounded theoretical framework (Glaser & Strauss, 1967) in that we are generating theory from the data that we gather. While we do recognize that we are also working within the framework of LET and that, to some extent, this is also guiding our theory generation, we are emphasizing the information derived from our investigation as the primary venue for understanding epistemic motivation.

We have been studying three classrooms in detail over the course of the present school year at an elementary school in a suburban college town. This particular school has one of the highest minority student populations in the district as well as serving some of the most economically disadvantaged neighborhoods. Of the three classrooms, two (a third grade and a fifth grade) are open to each other, and the two teachers in these classes conduct joint activities or lessons with both classes on a fairly regular basis. The third is a class of fifth grade students. All classes have between 20 to 25 students. In the fifth grade classes, we have also been conducting a study of student learning of electricity through a project-based science (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991) unit focusing on the question, "How do you light a house?" Project-based learning focuses, in part, on establishing a learning community within the classroom, as well as on the use of authentic tasks in learning. We have also collected survey data from a second school in which we have also been studying learning in essentially the same unit on electricity. This sample consists of five teachers covering grades two through five, in a school of similar ethnic and socio-economic background as our primary site.

We have used two primary sources of data to this point in our study. The first consists of a survey instrument based upon one developed for adults (Webster & Kruglanski, under review), used at both schools and in all eight classrooms. The second source of data consists of interviews of children and teachers at our primary site. While the focus of these interviews was on the nature of doing project-based science and on groupwork, the respondents clearly discuss issues related to their epistemological beliefs and this data has been quite helpful in our efforts so far. We also have field notes from classroom observations, as well as anecdotal evidence from the teachers and student journal entries that provide additional information.

Analysis of the Survey Instrument

In their work on epistemic motivation, Kruglanski and his colleagues (Webster & Kruglanski, under review) have developed an instrument to measure an individual's need for closure, the Need For Closure Scale (NFCS). This instrument is a 42-item, six-point Forced Choice Likert Scale survey covering five subscales: 1) Preference for Order, 2) Preference for

Predictability, 3) Decisiveness, 4) Close-mindedness, and 5) Discomfort with Ambiguity. Although the NFCS has been shown both to be a reliable instrument and to correlate highly with measures related to each of the subscales, we had several reasons for not using the instrument as is. Foremost is that, since it was developed as an adult measure, many of the item wordings simply were not applicable to elementary students or contained vocabulary that was not reasonable for children of this age. Our second reason had more of a theoretical basis. Given our doubts about the congruence of the construct of epistemic motivation at the adult and the elementary levels, we doubted that we would see the same factor structure as found in the NFCS. We believed that we would see an effect similar to another motivational scale, the Motivated Strategies for Learning Questionnaire, which shows a rather well articulated factor structure for adults but a much simpler and less articulated structure for middle school students (Pintrich & De Groot, 1990; Pintrich, McKeachie, Smith, Doljanac, Lin, Naveh-Benjamin, Crooks, & Karabenick, 1987). Finally, we were concerned about the influence of context in the wording of the items. Statements in the adult measure included many different settings; for the children's scale, we wanted to refer as much to schooling as we could to eliminate any discrepancies across contexts for learning and knowing.

Our efforts resulted in the first version of an instrument we call the Survey of Elementary Epistemic Motivation (SEEM). We created this version by, for the most part, translating the NFCS items into items that matched the language and the lives or contexts of our students, seeking the advice of two of our cooperating teachers on the wording of the items. Figure 2 shows the evolution of two items from the originals in the NFCS to our current version (version 2) of the SEEM. In the first version, we decided to drop one of the original items as untranslatable and modified the scale to a four-point Likert scale, giving us a total of 41 items. This format proved to be too challenging for a number of the students, particularly the younger ones who had difficulty with the length of the instrument. Exploratory factor analysis was used to examine the results of the survey. While it may be argued that confirmatory analyses are the "proper" way to conduct factor analyses, we state once again that our intent is <u>not</u> to <u>confirm</u> the

presence of the adult factors in the child sample. Rather, we see both the survey and the analysis as a tool in helping us to determine what the children in our sample see as important to them in terms of beliefs about knowledge; thus, the reason for using exploratory methods.*

In the end, the results from our first version were inconclusive, outside of the need for revision of the instrument. In general and as expected, we found that the adult factors not replicated with our sample. The closest replication was found for the Preference for Order and Close-mindedness subscales. Still, there appeared to be a core set of items that did hold some explanatory promise, particularly with the older students in our sample. In re-examining our instrument, we decided to revise it along the following lines: to cut down the total number of items, and to find some other means of presenting the items than the standard Likert scale format (Figure 2).

In order to narrow the number of items on the instrument, we constructed a correlation matrix so as to examine which items correlated moderately with the greatest number of other items on the instrument. In doing so, the instrument was eventually pared down to 23 items from the original 41. As for the format of the items, we decided to use Harter's (Harter, Whitesell, & Kowalski, 1992; Harter, 1981) Structured Alternatives format (Figure 2). In this format, students are given prompts for both a statement and its converse in the same item. Students need to decide which half of the item best describes themselves, and then decide on the degree of agreement. As such, it can be considered a comparable format to a four-point Likert scale. One major criticism that has been raised against such a format is the confusion the children might face in seeing two statements in one item, raising the possibility of the student responding to both halves of the items instead of just one. For the administration of our second instrument, we found this not to be an issue; less than 1% of our sample answered the questionnaire in such a way. In addition to these changes, we constructed both halves of the items with much more attention to keeping wording within the context of schooling, and we sought feedback from all our cooperating

* As such, we feel that reporting the numbers behind the results to be misleading for the purpose of this paper, as they are not the message of the analysis. For those interested in the statistics we ran or in furthering the discussion on instrument development, please feel free to correspond with us via surface or electronic mail (see title page).

teachers on both the format and the wording of the items. Of those who responded, the Structured Alternatives format was much preferred over the prior version.

The analysis of the second version of the SEEM was much more promising, though there were still some serious issues that we need to address in our next version of the instrument. First, we had to drop one class from our analysis, as it was administered incorrectly to those students. Second, the data from some of the younger students appeared suspect, as they had very low average scores on the items indicating that they marked mostly on the first halves of each items. This trend held in general as well, and implications of this are discussed below. Third, for the older students (fourth and fifth grades) we still ended with eight factors from the analysis, and for the younger students (second and third grades), nine factors were obtained. In comparing the two sets, some items remained together as core items on factors for both groups, while other items migrated between factors. While the sample size was too small to be conclusive (total N=141), we believe this does suggest developmental differences in how the students may be viewing the items. Finally, in comparison with the NFCS subscales, once again there was no correspondence between the factor structures of the two, outside of the tendency for several of the Preference for Order and Close-mindedness items to stick together, respectively.

What remains to be determined is what these factors mean to the students themselves. This will be discussed in greater detail below, but we would like to mention a few problems related to our current version of the SEEM. As mentioned above, our sample as a whole, and some of the younger students in particular, consistently chose prompts on the first half of the items. Several possibilities might explain this. One is that this is an artifact of the format, that younger children just will not pay attention to the second halves of the items. A second possibility is suggested by a reading of the instrument. It may be construed that, in wording the items, we placed what may be considered a "compliant child" response in most of the first halves of the items — that is, a prompt that describes what a "good" student would do or believe. Both of these possibilities can be tested to some extent by simply switching the order of the prompts on a substantial number of the items and readministering it to a portion of our whole sample. The

still high number of factors also indicates some possible problems. In examining the wording of each item, we have found what we consider to be phrasing that may prompt students to answer what should be related items in differing fashions. For example, some of the items describe groupwork settings, others describe doing work individually. Other items vary in terms of asking the students what they "like" versus what they "think" versus what they "are." Once again, such phrasing may or may not have an effect on how a student. This suggests an analysis from a social semiotic perspective (Lemke, 1990) might assist in determining the meaning that students make of these items.

One final note on the analysis of the SEEM. We see this instrument currently as a tool for guiding our further investigations. As mentioned above, we have yet to determine the meaning of the factors that we have found, and we are quite reluctant to assign them meaning without further study. This study will be guided, to some extent, by the nature of the interview data we have collected (as described below). What we will focus on in the immediate future is the determination of meaning of these items from three perspectives: those of the researchers, the teachers, and the students involved in this study. For the last two perspectives, we will soon be conducting interviews based upon the results of these analyses to probe the meaning that the students make of the items, as well as what meaning their teachers believe the students construct for them. Our purposes in describing our efforts here, besides developing an understanding of epistemic motivation, are to demonstrate the difficulty and the pitfalls in trying to translate theories generated about adults for children, as well as to document the process of trying to develop an instrument with both construct validity and reliability in measurement.

Analysis of the Interview Data

Interview data related to the SEEM was collected in the context of studying science learning and groupwork at our primary site. For the purpose of this paper, we will discuss findings from the interviews on groupwork, as they provided important information about the students' views related to epistemic motivation. The context of the interviews reported in this paper involved cross-age groupwork in the combined third-fifth grade classrooms. These were

two complete classes, each having its own teacher, but in a room with a folding wall between them. For most of the year, the teachers kept this wall collapsed so that the two classroom were combined, and in addition to a number of cross-age academic activities in science, math, reading, and art the two classes worked together on common social and management goals set-up by the teachers. Students were interviewed in pairs, often by a pair of researchers. These pairs were generally students of the same grade, but some cross-age interviews were conducted as well. Some same-gender as well as mixed-gender pairs were interviewed, and the overall set of respondents reflected the ethnic and racial make-up of the classes. A total of 11 interviews were conducted, involving approximately half (N=22) of the students in the two classes. Interview questions were unstructured and open-ended, with emphases on what experiences the students had doing the cross-age work and how they felt about such tasks.

Interviews were analyzed using the following constant comparative method. Transcripts were first coded by using *in vivo* coding (Chesler, 1987). This coding technique involves searching the text of the transcript for meaningful statements made by the participants. These statements are marked or underlined in the text, and removed from the text as well, becoming our "codes." The next level of coding was done with the in vivo codes. By comparing the statements from different interviews, these codes were organized into clusters of more general meaning. We generated a third level of codes with this new set of categories to obtain a greater level of abstraction and generality. Separate from this method involving successive abstraction from the data, the transcripts were also coded thematically: whole transcripts were read by the researchers and broad themes were identified in each. Once both of these methods were completed, the in vivo categories were compared with the thematic codes to help assess the credibility of the code categories.

Of particular importance for this paper is one of the best represented categories that emerged from the data — one that centered around "knowing." Both third grade and fifth grade students had clear notions of the nature of knowing (as they defined it), though they did differ to some extent. Among the features that both grades agreed upon are that knowing is quantitative

and cumulative, and so it is definitely age- or grade-related. They talked about fifth-grader knowledge and third-grader knowledge, and that certain types of knowledge are appropriate for different grades, as in this dialogue between two third grade girls:

> G1: When they're in fifth grade, they know different things.
> G2: And they're older than us, so they know a few more things than we do.
> G1: That's why they know different things. But, some are stuck, they don't know we know. Maybe they're going blank from when they were our age, or maybe it's just they don't know. They haven't learned. (11/p.5)
>
> . . .
>
> I: Is it just because they know different things or is it because they're in fifth grade?
> G1: Sort of both.
> G2: Uh-huh, that's what I'd say.
> G1: Because they're both the same thing. (11/p.5)

These excerpts demonstrate the point of view held by the third grade students. We also see this with the fifth grade students; the following excerpt is a description of how helping a fourth grader differs from helping a third grader:

> G: It'd be kinda hard and kinda easy.
> B: It'd be easy 'cause in fourth grade you be just learning division. 'Cause last year I was just learning division and I'm getting used to it double division now. And I could see a sixth grader trying to teach me to do double division. (09/p.5)

A third grade girl had this to say about what she knew compared to another third grader:

> We each pretty much have close to the same ideas, because we're in the same grade and stuff like that. We have similar ideas and stuff. (04/p.2)

Although, at face value, this view of knowing may not seem all that surprising given the nature of age-graded schooling, we did find this surprising for two reasons. First, this view of knowing was unanimous among the children of both grades. Second, as an explanatory mechanism, this view was quite forceful and powerful to the children, allowing them to explain a variety of events and differences in their experiences. Overall, it is a rather lockstep view of learning that suggests the need for further investigation, to better identify the students' beliefs about just how incremental their ability to learn may be.

Also of interest were statements that showed evidence of the workplace/factory metaphor of schooling. One common response for both grades, in terms of describing someone who would be a good partner to work with, was someone who "knows a lot." As such, both the third and the fifth grade students saw fifth graders as the best partners to have. Many of the fifth grade

students added another dimension to their idea of good performance – that of speed. One of the biggest complaints that the fifth grade students had about their younger partners was that they would slow the fifth graders down. Both of these views of the "good partner" seem to indicate that what is valued in school, perhaps what is fostered by the culture of schooling, is an epistemic state of seeking non-specific closure. In other words, get any answer as quick as you can, and that should be good enough. This is borne out as well in the statements of two third grade girls on how they determine when an answer is correct:

G1: We work together. We just agreed, like if we turned our computers, right and if both is right then we just put the answer down and if both, if his is right and mine is wrong then we do it over again and then if they both the same we put it on the answer thing.

I: How did you know if they were right or wrong? How did you know who was right or wrong?

G2: Because we check it on the calculator, like we punch it in and if it's wrong we erase it and put the right answer. (12/p.6)

In other words, if we both agree, then it must be right ... time to move on to the next problem!

At our present level of analysis, it is still premature to make any broad statements about the nature of epistemic motivation in children. As is consistent with our method, we need to use our present data to help define and design our next round of interviews and investigations. While there is a large amount of agreement across all of our respondents with respect to these basic issues, there are still some subtle points that need to be examined in greater detail. For example, one striking impression to the researchers analyzing this data set was the surprisingly sophisticated views of learning that the third graders had when compared to the fifth graders. Given the size of our sample, this may be due solely to the teachers of each respective class. On the other hand, it may show a developmental trend indicating the extent to which these students have figured out the "game" of school and have decided to play by it's rules. Either way, we found it quite encouraging to hear comments such as from this interview with two third grade boys:

I: Okay, why are (the fifth graders) good?
B1: Because they know lots of stuff, and I like to learn from stuff. You know, I made a mistake, and (a fifth grader) told me what to do.
B2: I don't think that's right! I mean that's kind of like telling the answer. I think you should figure it out yourself. I think that's how you learn it yourself. (14/p.11)

. . .

B2: I mean, just getting the answers, that's not learning. (14/p.13)

Extending the Construct of Epistemic Motivation

As discussed in several places above, our work is still very much in progress due to the nature of our grounded theory approach. All the same, the data we have so far suggest that the construct of epistemic motivation is in need of revision if we are going to apply it meaningfully to children's learning and knowing. While we wish to let the data speak for itself, we also feel that there are other models and theories in the educational literature that can inform our work as well.

One reasonable comparison to epistemic motivation from the motivational literature is student goals for learning; whether a student is intrinsically focused and interesting in learning in and of itself, or whether he is extrinsically focused and interested in some reward, such as a high grade, more than in learning. Pintrich and Garcia (1991) have suggested that rather than viewing these motivational states as two ends of a continuum, that the two may be separate and, therefore, a student may have both intrinsic or learning goals as well as extrinsic or performance goals. While we do not have the data to support this, it appears logical that a similar effect may exist between specific and non-specific closure. Considering the nature of the cost/benefit analysis involved with epistemic motivation, the types of situational cues that seem to influence epistemic states tend to divide such that task performance cues, such as time constraints, align with non-specific closure states, while task content cues, such as having the correct answer, align with specific closure states. If such were the case, there would be important implications for conceptual change instruction. In one sense, the teacher would want to structure tasks so that students would eventually settle for only the scientifically-accepted conception (seeking specific closure), but at the same time making sure that they extended their search for knowledge and did

not settle on the first reasonable answer they find (avoiding non-specific closure). Clearly, the ability to hold and to foster both epistemic states simultaneously would provide greater explanatory power to the model.

Another issue that has appeared time and again in this paper is that of the culture of schooling. In Doyle's (1983) examination of academic work, he describes two dimensions along which school tasks can be said to vary —the *ambiguity* involved in solving the task as well as the *risk* involved. A task low in both dimensions would be a pure memory task, as would one low in ambiguity but high in risk. A task high in ambiguity but low in risk would involve opinion, while one high in both dimensions asks for understanding. As Doyle points out, when students are faced with tasks that are high in either dimension, they typically attempt to negotiate task with the teacher so as to reduce the level of that dimension, and quite often they succeed. This is all consistent with what has been described as the workplace or factory model of schooling current in our educational system. It is a model which does little to foster the sort of learning that would result in conceptual change.

On the other hand, more recent models of learning seek to "raise the stakes" and engage students conceptually in their learning. Examples of these are project-based learning (Blumenfeld et al., 1991), intentional learning (Bereiter, 1990), and complex instruction (Cohen & Lotan, 1990). What each of these models have in common is the notion of changing the context and culture of school learning to that of a learning or discourse community, where all are engaged in constructing knowledge through solving ill-defined problems. Such environments would encourage the beliefs about knowledge, the epistemic states, most likely to support conceptual change learning, whereas the current, typical context for learning in our classrooms tends to circumvent this. In terms of extending our understanding of epistemic motivation, we still need to find out whether these instructional methods can actually influence a student's epistemic beliefs, and to what extent this will occur within the context of an entire school which may or may not follow the same instructional method or metaphor for learning. In other words, is the workplace metaphor too ingrained into our students' understanding of how school works, or will

we be able to test these theories and models within the limits of changing one or two classes at one time?

For this paper, we have had several goals, but as important are the goals we did not have. One which we did not hold was trying to demonstrate a fit between Lay Epistemic Theory, as is, and children's beliefs towards the knowledge building process. What we primarily wanted to accomplish was to provide an explanation of the theory and the construct of epistemic motivation, and justify its theoretical value in informing the science education community's understanding of conceptual change and related motivational issues. We also hoped to illustrate some promising venues for exploring how epistemic motivation may be exhibited in children engaged in conceptual change learning, and the direction that these paths are leading our current research efforts. As this work has been a starting place for our investigations, we hope that it provides insights for those wishing to examine the links between motivation and conceptual change learning in their own work.

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	Disposition towards closure	
Specificity of closure	avoiding	seeking
non-specific	*avoids non-specific closure*	*seeks non-specific closure*
specific	*avoids specific closure*	*seeks specific closure*

Figure 1: The Four Epistemic States, after Kruglanski, 1990a

NFCS Examples
6 point Likert scale, 42 items

Even after I've made up my mind about something, I am always eager to consider a different opinion.

When considering most conflict situations, I can usually see how both sides could be right.

SEEM v.1 Examples
4 point Likert scale, 41 items

Even after I've made up my mind about something, I am willing to listen to a different idea.

1	2	3	4
not at all like me	not much like me	a little like me	a lot like me

In most arguments, I can usually see how both sides could be right.

1	2	3	4
not at all like me	not much like me	a little like me	a lot like me

SEEM v.2 Examples
Structured Alternatives format, 23 items

Really true for me	Sort of true for me				Sort of true for me	Really true for me
☐	☐	Some kids won't listen to other ideas once they've made up their mind	**BUT**	other kids want to listen to new ideas even if their mind is made up.	☐	☐
Really true for me	Sort of true for me				Sort of true for me	Really true for me
☐	☐	Some kids can see how lots of ideas could be right	**BUT**	other kids think that only what they believe is right	☐	☐

Figure 2: Sample Items from the NFCS and SEEM, versions 1 & 2